PB-215 132

SAN JOAQUIN VALLEY AND SACRAMENTO - SAN JOAQUIN DELTA CALIFORNIA. A PRELIMINARY EVALUATION OF STREAM FLOW REQUIREMENTS FOR WATER QUALITY CONTROL

Public Health Service
San Francisco, California

June 1963

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

66

PB 215 132

SAN JOAQUIN VALLEY

&

SACRAMENTO - SAN JOAQUIN DELTA
CALIFORNIA

A Preliminary Evaluation of Stream Flow Requirements for Water Quality Control

RECEIVED
LIBRARY
MAY 13 1969
FWPCA, OHIO BASIN REGION
4676 COLUMBIA PKWY., CINTI, O. 45226

DEPARTMENT OF HEALTH, EDUCATION & WELFARE
Public Health Service, Region IX
San Francisco, California

In Cooperation with the

DEPARTMENT OF THE INTERIOR
Bureau of Reclamation, Region 2
Sacramento, California

June 1963

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. Department of Commerce
Springfield VA 22151

13

CHAPTER VI

WATER QUALITY CONTROL BENEFITS

Water quality control benefits are defined as the net contribution to public health, safety, economy, and effectiveness in use and enjoyment of water for all purposes which are subject to detriment or betterment by virtue of change in water quality.

The protection of public health through the provision of safe and potable water supplies has long been a matter of primary concern to the Public Health profession. However, the problem of providing adequate quantities of water with suitable quality for all beneficial uses has become increasingly difficult due to the pyramiding water demands of the rapidly expanding economy. Furthermore, the resulting increase in waste and land drainage flows in combination with increasing upstream depletion of the streams has caused a gradual degradation in the quality of the San Joaquin Valley's waters and has decreased their value for many beneficial uses. Salt water incursion has further complicated the water quality problem.

The relatively poor water quality conditions which have prevailed in the lower San Joaquin River and Delta system have resulted in water quality problems to municipal, industrial, agricultural, fishing, and recreational users. Industries have suffered considerable expense for water treatment equipment and chemicals, production has been slowed and in some cases, plants have been forced to shut down for short periods. Penalty costs incurred by industrial water users in the Contra Costa Canal Service area in 1961 due to chloride content in excess of 100 ppm and/or total dissolved

solids greater than 400 ppm ranged from $1000 to $158,700 per year and totaled $354,250.[2/] Municipal water supplies have fallen below U. S. Health Standards and have resulted in complaints on taste, odor and color as well as complaints regarding hardness as it effects cloths and dish-washing. Agriculturists have suffered excessive leaching costs, lower income from reduced crop yields, restriction to salt tolerant crops, and in some cases physical damage of crops due to excessive salinity. Warren R. Schoonover estimates that due to increasing salinity in irrigation water supplies excess costs in West Stanislaus, Banta Carbona, and Patterson irrigation district totaled $809,900 through 1961.[3/] The fishery resource has suffered from depletion of stream flow and from pollution by organic wastes and chemicals of known toxicity. Numerous fish kills have occurred in the Delta and lower San Joaquin River as the result of seasonal organic waste discharges. Skinner[7/] reports that the annual value of the commercial fisheries resource in the San Francisco Bay area, including the Delta, is between $13,500,000 and $18,300,000 annually. Recreationists have been confronted with nuisance odors and degradation of the esthetic enjoyment of streams. This problem has become acute in the Stockton area during the food processing season.[6/]

The quality objectives and related flow requirements recommended in this report ~~are designed~~ for achievement of the following purposes:

1. Protection of the public health and welfare.
2. Prevention of nuisance conditions.
3. Provide an environment suitable for the propagation of resident and anadromous fish life.

4. Reduce concentrations of chemicals and minerals and enhance the natural self-purification capabilities and assets of the streams.
5. Enhance the aesthetic values of the streams and adjacent areas.
6. Sustain and protect the vast agricultural and industrial productive wealth of the basin and to support the continued expansion of industrial and agricultural development and population growth.

The primary beneficiaries of the proposed water quality control program are the resident population of the San Joaquin Valley and large numbers of visitors who utilize the streams in the basin for fishing, boating, skiing and other recreational purposes. By virtue of the multiplicity of values (tangible and intangible) that are derived through maintenance of stream quality and the large number and varied nature of the people to whom these benefits accrue, the benefits attributable to measures specifically designed to achieve water quality control through stream flow regulation may be regarded as widespread and in harmony with the National goals for pollution control.

Various methods have been proposed for the economic evaluation of water quality control benefits. Ideally, economic assistance toward solution of water pollution problems in the San Joaquin Valley, would be realized by the development of a system of analysis, which would approximate an optimal system for the disposal of the valley's present and future wastes and which would distribute the costs thereof in an equitable manner. Such an optimal system of waste disposal would undoubtedly include various levels of waste treatment, manufacturing process and product changes, shifts in plant locations, alternative methods of waste disposal, consolidation of

wastes for treatment, low flow augmentation, and other practices and measures to reduce the volume of wastes and to decrease pollution damages. Under the optimal system, all costs of the waste disposal service, including the costs of pollution damage, would approach a minimum. Expenditure to reduce costs of waste treatment or pollution damages, or a combination of the two, would tend to be made as long as each dollar spent resulted in a reduction in costs of more than one dollar. At the point where marginal cost equalled marginal benefit, costs of waste disposal including the costs of waste treatment and pollution damages, would be minimized. Conversely, at this point total benefits from a comprehensive pollution control program would reach a maximum.

The above objective is approached in more orthodox lines of production and consumption of goods and services when the costs and benefits of producing given products fall fully upon the plants which produce them. The market place is relied upon to efficiently allocate resources in the production of the quantity and quality of goods and services desired by society. Unfortunately, with respect to the services of waste disposal, the costs of production are usually not fully incurred by the producing unit but are transferred to other units or users. This tends to induce over-production and consumption of some goods and services and under-production or exclusion of other goods and services. For example, a canning company which discharges its wastes in a stream without bearing any of the downstream costs (pollution damages) produces canned goods at less than the actual cost to society. The company pays nothing for waste disposal in the stream or for degradation of the stream to downstream users. Failure of the polluter to consider the value of water to other users, which is

made less valuable or its use is prohibited by his pollution is the basic element in the determination of economic efficiency and the crux of the pollution problems. From the standpoint of society, the value of water is measured by its alternative uses.

Because the polluter can dispose of his wastes by discharging them into the stream without incurring the full social costs thereof, his incentive to design and operate industrial processes, treatment plants, and other measures to reduce wastes and minimize costs, including pollution damage, is less than if he were required to meet the full costs.

In practice, the water quality control objective is approached by the imposition of stream standards, effluent standards, or effluent charges and by zoning or otherwise controlling industrial location. To use any of these devices, in an ideal manner, requires detailed information on numerous parameters, including opportunities and costs of process and product adjustments, locational advantages and disadvantages of particular sites, alternative methods and costs of waste treatment, and detailed information on downstream pollution damages. This essential information is frequently very difficult to quantify and requires special methodology and data collection techniques.

Due to the complexity of the problem, the short period of time available for this report's preparation, the need to expand greatly, investigations to more adequately identify, quantify and evaluate pollution damages, and to refine present data, this report must be considered as an initial reconnaissance of the pollution problem.

Furthermore, the scope of the following discussion is restricted to one of three basic methods for water pollution control, namely, stream

flow regulation. The other two methods, elimination of the waste at its source, and treatment of the wastes to remove pollutants were, of course, included in the above discussion of the optimal system of waste disposal at minimum cost. Stream flow regulation for quality control is the third line of action. Even after application of the best feasible waste treatment practices presently known, some pollutants escape to enter the stream. These residual pollutants cause adverse conditions in downstream waters and nessitate the augmentation of stream flows during periods of low stream flow to prevent pollution damages and/or to enhance downstream water uses.

Many alternative sources of water for water quality control are available. These include ground water, stream flow, in-basin impounded water, and imported water. Detailed information on the best alternative source of water needed at specific locations on individual rivers at population concentration points is unavailable at this time. Presumably, as the need for water for water quality control becomes more clearly identified and the need increases with population growth and industrial development, water for this purpose will be allocated from existing and potential water resource developments of federal, state and other public agencies.

The value of benefits from water quality control may be approximated by the cost of achieving the same results by the most likely alternative. The most likely alternative source of water for water quality control would probably be the construction of a single purpose storage reservoir at one or more of the sites in the San Joaquin Valley currently being considered for potential development. Since time and fund limitations restricted the amount of detailed information which could be assembled and analyzed, it was not possible to specifically identify the most likely alternative single

purpose reservoir at each location of water need. The average costs of constructing storage reservoirs by size class were therefore utilized to indicate the relative magnitude of annual benefits which might be realized from water quality control through stream flow regulation. Cost data developed by the California Department of Water Resources 5/ and by the Senate Select Committee on National Water Resources 4/ were utilized for this purpose.

The Senate Select Committee developed estimates of future reservoir storage costs in Water Resource Regions of the United States. In developing estimates of reservoir storage costs by size class, the Committee used a distribution of existing (1954) reservoirs by size class, as a general pattern. The existing distribution was then modified to represent future conditions by adjusting for degree of regulation currently achieved and distribution by size class in each water resource region. No use was made of the largest reservoir size class, 10 million acre-feet and over, and for many regions, none of the smaller classes of reservoirs were used. Exclusion of the large reservoirs contributes an upward bias to the whole cost curve and exclusion of the small capacity reservoir, a downward bias in marginal costs of the small increments of capacity.

Costs of storage were estimated by increments of storage after taking into account the physiography of the water resource region. The estimated cumulative distribution of capacity in each region by size class of reservoirs and the cumulative annual costs, including amortizations, for each water resource region were available from the Senate Select Committee Report No. 32. From these cost data the annual cost per acre-foot of storage capacity by size class was computed for the Central Pacific Water Resource

Region. The resulting costs were adjusted to reflect 1962 price levels by means of appropriate construction cost indexes and are shown in Table VI-1. Reservoir storage costs averaged $2.42 per acre foot of capacity and ranged from a cost of $7.92 per acre foot for reservoirs under 20,000 acre-feet capacity to $1.24 per acre foot for reservoirs in excess of 4,000,000 acre-feet capacity.

Dam and reservoir capital costs for 54 potential reservoir sites located in the San Joaquin-Sierra mountain area were estimated by the California Department of Water Resources.[5/] Estimates of costs were based upon 1955 price levels. Net storage capacities of these potential reservoir developments ranged in size from 5,000 to 1,610,000 acre-feet. These reservoirs were classified by size, capital costs per acre-foot of net storage capacity were computed for each size class, costs were adjusted to reflect 1962 price levels, and annual costs of storage capacity including amortization and operation and maintenance costs were estimated. For the 54 reservoirs, the estimated annual costs per acre-foot of net storage capacity averaged $3.54, (Table VI-1). Annual costs ranged from $11.47 per acre-foot for reservoirs with less than 10,000 acre-feet of capacity to $2.79 for reservoirs with more than 500,000 acre-feet of capacity.

The estimated annual costs of reservoir storage capacity by size class for the San Joaquin-Sierra group of reservoirs compare favorably with those developed using Senate Select Committee data for the Central Pacific Region. The higher cost for the lower size classes of the San Joaquin-Sierra group are partially due to the inclusion of smaller reservoirs and to difference in the width of the size classes. With more detailed study,

TABLE VI-1

ESTIMATED RESERVOIR STORAGE COSTS BY SIZE CLASSES

Central Pacific Region[1]			San Joaquin-Sierra Mountains Area[2]			
	Annual Cost[3] per Acre-Foot - (dollars)			Capital Cost per Acre-Foot (dollars)		Annual Cost per
Size Class (1000's acre-ft)	1959	1962[4]	Size Class (1000's Acre-Feet)	1955	1962[4]	Acre Foot
4000 - 9999	1.13	1.24				
2000 - 3999	1.45	1.59				
1000 - 1999	2.03	2.22				
400 - 999.9	2.39	2.61	500 & over	47.02	62.02	2.79
200 - 399.9	2.87	3.41	150 - 499	44.31	58.53	2.63
100 - 199.9	3.53	3.86	80 - 149	76.67	101.28	4.56
60 - 99.9	4.02	4.39	50 - 79	131.23	173.23	7.80
50 - 59.9	5.82	6.37	30 - 49	124.27	164.16	7.39
20 - 39.9	5.59	6.11	10 - 29	147.81	195.26	8.79
under 19.9	7.24	7.92	under 10	192.97	254.91	11.47
Average all classes		2.42				3.54

[1] Computed from data in Committee Print No. 32, Water Resources Activities in the United States, S. Res. 48, 86th Congress, 2d Session, 1960.

[2] Computed from data in Bulletin No. 3, The California Water Plan, State of California Department of Water Resources, 1957.

[3] Includes amortization of construction costs

[4] Cost adjusted to reflect 1962 price level

specific reservoirs included in the San Joaquin-Sierra group would probably be selected as alternative sources of water for water quality control at specified locations within the San Joaquin Valley.

Costs for this group are, therefore, suggested for use in indicating the probable value of water quality control benefits.

Based upon the analytical method of estimating benefits from stream flow regulation by means of the least cost alternative, stream flow regulations benefits, which could reasonably be expected to accrue per acre foot of reservoir storage capacity required, are shown in Table VI-1. If an allowance of 25 percent to cover the losses incurred in transporting storage water from the reservoir to the place of need were made and, for purposes of analysis, it is assumed that water equal to the annual storage requirement would be available, then the estimated incremental benefit of stream flow regulation would range from $14.34 per acre foot of storage water required for increments of 10,000 acre feet to $9.75 for increments of 50,000 acre feet. These values compare with a recent reported contract price of $10.00 per acre foot for the future delivery in the area of raw municipal and industrial water.

To actually compute the cost of storage water delivered to a given point, it would be necessary to know the storage capacity required to deliver an acre foot of water at the place of need. This relationship between storage capacity and water yield would be dependent upon several factors including seasonal and annual variations in the total stream runoff, the degree of existing regulations, the presence and characteristics of occurrance of surplus water available for storage, and evaporation and transmission losses.

The quantity of storage water required in the future for stream flow regulation for quality control will also be dependent upon the relationship between the quantity of water required to maintain or enhance fish and wildlife, recreation, power, irrigation and other uses of water and the quantity required to assimulate waste treatment plant effluents and other pollutants which cannot be controlled at the source.

Detailed hydrological information on future stream flows which can be anticipated with the planned development and use of the water resources for the various purposes in place are not yet available. As estimates of the future hydrologic conditions of the streams are developed and as more detailed information on pollution damages, and alternative costs of pollution control are developed the above reconnaisance estimates of stream flow regulation benefits will be subject to modification.

CHAPTER VI

BIBLIOGRAPHY

1. Allen, V. Kneese, Economic Analysis in Water Quality Management, 1962.

2. U. S. Department of Health, Education, and Welfare, "An Evaluation of the Economic Benefits Derived from the Improvement of Water Quality in Contra Costa Canal," 1962.

3. Schoonover, Warren R., "Quality of Water in Lower San Joaquin River as Related to Agriculture," 1963.

4. Select Committee on National Water Resources, U. S. Senate Water Resources Activities in the U. S., Committee Print No. 32, 1960.

5. State of California, Department of Water Resources, The California Water Plan, Bulletin No. 3, 1957.

6. State of California, Department of Public Health, Stockton Delta Area Water Quality and Water Use Survey, August, 1962.

7. Skinner, John E., "An Historical Review of the Fish and Wildlife Resources of San Francisco Bay," Water Projects Report No. 1, California Department of Fish and Game.